Modelling regional economic effects of the Öresund link -linking two regional economic models

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ABSTRACT: The Öresund link, opened in July 2000, is a sixteen-kilometre fixed link with several specific characteristics. E.g., the link connects two countries, Denmark and Sweden%2C and two urban areas, Copenhagen and Malmö, with 1%2C5 and 0,5 million people, respectively. Further, the fixed link reaches Denmark nearby Copenhagen Airport, which implies easy access to an international airport for a lot of people in Southern Sweden. No doubt, a fixed link with these features will influence the regional interaction and regional development in many ways.

Defining a suitable model approach for assessing the regional economic consequences of the fixed link raises several challenging issues: The problem of dealing with border barriers, the choice between regional and multiregional approaches, the difficulty of modelling short term as well as long term effects. These issues seem too complicated to be dealt with within a single model framework.

The paper presents one limited model approach. Two regional economic models, LINE in Denmark and RAPS in Sweden, are linked to each other by a common interaction module, where flows from/to the respective part of the Öresund region are being modelled, with respect to trade, commuting and migration. Preliminary model results are presented, mainly dealing with the impact of building the link.

1 Introduction

The Öresund link connects Denmark and Sweden by a sixteen-kilometre fixed link, part tunnel, part bridge. It is is a major infrastructure investment, comparable to, e.g., the recently built fixed link across Storebælt, connecting East and West Denmark. But the Öresund link has some important characteristics, in distinction to most other major infrastructure investments.

First, two different countries are connected. Even though the geographical distance is quite small, the perceptual distance is quite large, due to *border barriers*: Two different languages, jurisdictions, currencies etc. A crucial question is to which degree the fixed link will reduce these border barriers. Second, the fixed link connects two urban areas. On the Swedish side, Malmö is a middle-sized city, situated nearby Lund, which is an old city with a large university. On the Danish side Copenhagen is the capital with its characteristics, i.e. universities, central administration etc. Third, the fixed link reaches Denmark nearby Copenhagen Airport. This implies easy access to an international airport for a lot of people in Southern Sweden. No doubt, a fixed link with these characteristics will influence the regional interaction and regional development. A rough outline could be along these lines:

In the short term travel and transportation cost is reduced for existing traffic across Öresund. The number of trips will increase and the travel pattern will change. Some workers will start commuting to the neighbouring country, to get higher pay or a better job in other respects. Trips for other purposes and freight traffic will also increase.

In the medium term other effects appear, as households and firms are relocating to the neighbouring country. People will move for different reasons, e.g. proximity to the place of work, lower housing cost, cultural supply or other amenities. For similar reasons some firms may have incentives to relocate. Reduced transportation costs can make it profitable for an enterprise to move across the strait, if it means, e.g., more value for money of office space.

In the long term additional effects are expected. An integrated Öresund region with more than 2 million people will be more beneficial in terms of possible specialization and scale economies, than what is feasible within two poorly integrated regions with 0,5 and 1,5 million people, respectively. Further, among European companies the “new” Öresund region will probably be more attractive as a place for location than the two regions of today.

This rough and general outline raises several challenging issues, as we turn to the question of defining a suitable model approach for assessing the regional economic consequences of the fixed link: For example, the problem of dealing with border barriers, the choice between regional and multiregional approaches, the difficulty of modelling short term as well as long term effects. These issues seem too complicated to be dealt with within a single model framework.

The reduced transportation costs that the Öresund link will bring about are not confined to the vicinity of the link, but have a rather wide spatial extension (Øresundskonsoriet, 1999). This could be one reason to apply a multiregional model. In a similar context, evaluating the impacts of the Channel Tunnel on economic development, the MEPLAN transport and regional economic model was applied where the EC area was divided into 33 regions (ACT et al., 1994). Recently Bröcker (1998) has applied a

computable general equilibrium model to 805 regions, covering the entire European space, analysing the economic impacts of the TEN project (including the effects of the Nordic Triangle, and the Öresund link).

Developing a large multiregional computable general equilibrium model is feasible, provided that the model is fairly uncomplicated, excluding sectoral details etc. But, as argued by Bröcker, a less 'realistic' model can still be more appropriate than a large scale econometric or input-ouput model, if it offers better possibilities for studying the interaction between prices and quantities in a theoretically consistent framework. And, a major question as to the economic impact of the Öresund link is certainly its price effects, stemming from reduced transport costs.

Nevertheless, we suggest a model approach which, at least initially, offers less opportunities to simulate the 'price effects' in a theoretically consistent way. On the other hand, in the suggested approach, greater sectoral details also implies that demography and labour market are integral parts of the model. This seems necessary, if we expect impacts on the labour market (commuting) to be as important as impacts on trade of goods.

Our pragmatic approach means an attempt to link two already existing regional economic models: RAPS[1] and LINE[2]. It should be stressed that developing an entire new model, or to enlarge the geographical area of one of the existing models, would be far beyond the scope for the project. The goal is, for ex ante analyses, to forecast the economic impacts of the fixed link, and for ex post analyses, to be able to distinguish the impacts of the fixed link from other changes in the economy.

The models are quite different, implying a major challenge to sort out these differences, and to judge whether and how the models can be linked in a sensible way. A central purpose of this paper is to present the models and these differences. It should also be stressed, what has been hinted at above, that several tools should be used when evaluating large-scale investments in the transportation system, also with respect to the economic impact. For a discussion of different approaches, see Madsen and Jensen-Butler (1999).

The paper is organised as follows. Section 2 presents different economic facts and figures of the region today, also concerning the interaction across Öresund. In section 3 and 4 the two regional models, i.e. RAPS and LINE respectively, are presented. In section 5 the linking of the two models is discussed, with differences between the models as a point of departure. Section 6 concludes.

2 The Öresund region: Some economic facts and figures

The Öresund link is number two out of three fixed link, either newly build or under discussion in Denmark in these years. The first is the opened Great Belt link between East and West Denmark, while the third link is still under discussion: the Fehmarn Belt link, connecting East Denmark and Germany. By judging only from a map, it could be expected that the interaction between Zealand and the areas connected by the three respective links would be almost identical in size. In West Denmark, Århus and

[1] RAPS is a new model system, developed by Statistics Sweden in co-operation with INREGIA, Sweden and SINTEF, Norway. The project was assigned by NUTEK (Swedish National Board for Industrial and Technical Development).

Odense, which are the second and the third largest cities of Denmark, are situated; In Sweden, Göteborg and Malmö - also the second and the third largest cities – are located quite close to the fixed link. In Germany, Kiel and Lübeck are main cities located rather close to the link. In reality, there are, however, substantial border barriers, as well as other factors, which differentiate the three bridges. Probably these differences also influence the consequences of the fixed links.

It is always difficult to compare numbers from different countries, due to different definitions, different methods, different currencies etc. However, in co-operation Statistics Denmark and Statistics Sweden have published several numbers on the Öresund Region (Danmarks Statistik and Statistiska centralbyrån 1999). The delimitation of the Öresund Region which is used in this publication is illustrated in figure 1. The region covers Sjælland, Lolland-Falster and Bornholm in Denmark and Skåne län in Sweden.

In table 1 several key numbers of the region are shown. For comparison numbers for entire Denmark and Sweden are also shown. The numbers are the latest possible, notice that this point differs.

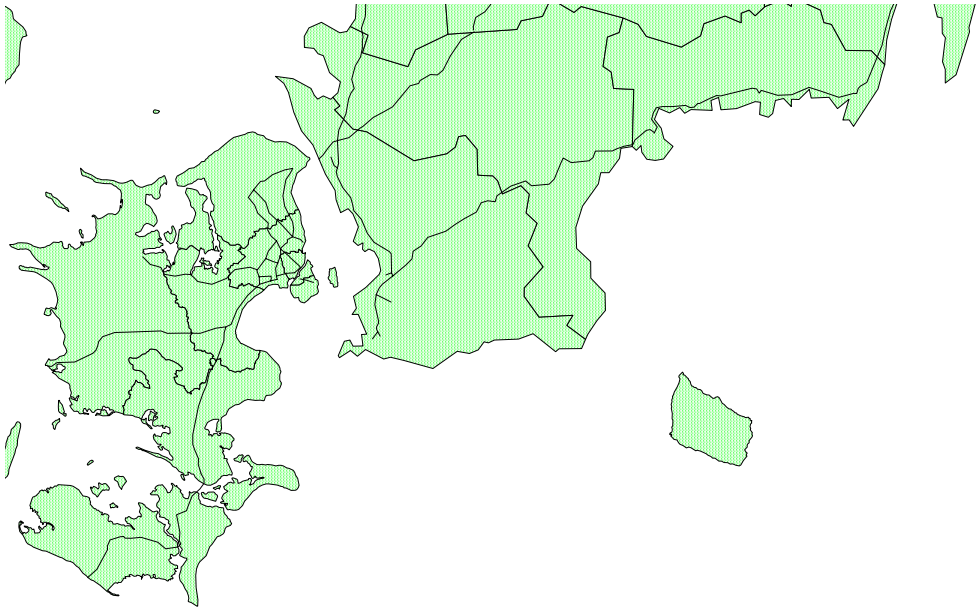

Fig. 1 Map of the area

It is seen that the population is larger in the Danish part of the Öresund Region than in the Swedish part. Since the area is smaller than in the Swedish part (9,832 km^2 as opposed to 11,027 km^2), the population density is higher in the Danish part. The number of employed persons and the employment frequency is substantially higher in the Danish part of the region than in the Swedish part. There are age and sex differences in this pattern. In Denmark a substantially higher share of the young people work than in Sweden, while in Sweden the share of working people among old persons is higher, especially for women. Furthermore, it is seen that the rate of unemployment in Sweden was a bit higher than in Denmark. (Notice that the rate of unemployment is seen relative to total population in the age group).

[2] LINE is a model developed at AKF, Institute of Local Government Studies in Denmark.

Table 1 Key figures of the Öresund Region

	Öresund Region, Denmark	Öresund Region, Sweden	Entire Öresund Region	Entire Denmark	Entire Sweden
Total Population Ultimo 1998	2,383,253	1,120,426	3,503,679	5,313,577	8,854,322
Population, Age 16-59 Ultimo 1996	1,470,819	644,391	2,115,210	3,245,936	5,136,688
Employed persons Age 16-59 Ultimo 1996	1,115,055	427,116	1,542,171	2,487,694	3,569,943
Employment frequency (share of total population, age 16-59) November 1996	0.76	0.66	0.73	0.77	0.69
Fully unemployed persons, Age 16-59 November 1996	89,294	48,367	137,661	183,460	347,014
Rate of unemployment (share of total population, age16-59) November 1996	0.06	0.08	0.07	0.06	0.07
Gross Product 1996 (m. USD)	90,538	29,003	119,541	183,964	251,745
Gross Product 1996 (USD) per inhabitant	38,496	26,057	34,500	34,954	28,475

Source: Danmarks Statistik and Statistiska centralbyrån (1999)

As is seen from the table, the gross product in the Danish part of the Öresund Region was bigger than the gross product in the Swedish part of the Öresund Region in 1996. This is true in total, as well as per inhabitant. Furthermore, on the Danish side, the gross product per inhabitant is bigger in the Öresund Region than in the rest of the country, while the opposite is true for Sweden.

The sector distribution of the employment in the two parts of the Öresund Region is shown in table 2. Of total employment in the Swedish part, the industry share is 20 %, compared to only 12.8 % in the Danish part. Thus, different service sectors constitute a larger share of the employment in the Danish part, than in the Swedish part. Trade and repair, hotels and restaurants, transport, bank etc, business service etc, public administration etc, education, health and welfare institutions etc, gives in total 72.5 % for the Danish part and 64.2 % for the Swedish part.

One could have expected larger differences in the sector distribution, since Copenhagen is included in the Danish part of the region. However, some quite different areas are included as well, e.g. rural areas. Besides, the Swedish part of the region also includes a large university (in Lund), as well.

Table 2 The sector distribution of the employment in the two parts of the Öresund Region. Ultimo 1996

	Öresund Region, Denmark		Öresund Region, Sweden	
	Number of employees	Per cent	Number of employees	Per cent
Agriculture, hunting, forest	19,205	1.66	12,990	2.88

Fishery	1,153	0.10	99	0.02
Raw material extracting	1,039	0.09	601	0.13
Industry	148,028	12.80	90,461	20.08
Electricity, water supply etc.	8,113	0.70	3,048	0.68
Construction	67,855	5.87	26,176	5.81
Trade and repair	178,890	15.47	58,851	13.06
Hotel and restaurants	32,483	2.81	8,654	1.92
Transport	88,161	7.63	29,562	6.56
Bank, finance, insurance	44,241	3.83	7,100	1.58
Business service, property etc	120,348	10.41	39,285	8.72
Public administration, defence, social security	93,231	8.06	24,336	5.40
Education	85,533	7.40	32,332	7.18
Health and welfare institutions etc.	195,328	16.90	88,935	19.74
Organisations, amusements, culture etc.	65,522	5.67	18,031	4.00
Private households with staff	494	0.04	1	0.00
Unknown	6,336	0.55	10,017	2.22
International Organisations	164	0.01	0	0.00
Total	1,157,124	100	450,479	100

Source: Danmarks Statistik and Statistiska centralbyrån (1999)

Various types of interaction across Öresund take place, but only very limited data on this interaction is available. Different attempts have yet been to give estimates of some of the numbers. As further described in section 6, different initiatives have been taken to produce valid data in the future.

There are no official statistics on the number of commuters crossing Öresund, but Bacher et al. (1995) present an estimate, based on different assumptions. The number of employees living in Sweden and working in Denmark in the autumn 1994 was estimated to 1 470, while employees living in Denmark and working in Sweden was estimated to be 480. These numbers can be compared with 'natural commuting', i.e. in the case of no border barriers. A comparison can also be made with the expected commuting, given the fixed link, with or without border barriers, reflecting commuting in the short and long term, respectively. The natural commuting amounts to 8 900 persons, implying large border barriers. The fixed link will only influence some of the commuters (others will still use the ferries, e.g. between Helsingør and Helsingborg). According to Bacher et al. the number of commuters with a fixed link, and

with border barriers will be around 8 100 persons, determined via simple push-models of the gravity type. Of course, these numbers are uncertain in many ways, but there is no doubt that commuting is relative low, due to the border.

Table 3 Exports and imports from/to Greater Copenhagen to/from South Sweden and West Denmark in 1990, and calculated border barriers.

	Exports			Import		
	West Denmark (1)	South Sweden (2)	(2)/(1) *	West Denmark (1)	South Sweden (2)	(2)/(1) *
	m. DKK	m. DKK	Per cent	m. DKK	m. DKK	Per cent
Food	5,890.1	199.4	4.3	5,808.1	149.9	3.3
Construction/ Housing	249.6	90.8	46.4	2,324.2	144.2	7.9
Medical/health	642.3	80.7	16.0	0.0	75.1	-
Transport/ Communication	1,527.4	347.9	29.1	2,181.9	115.1	4.6
Environment/ Energy	1,314.9	85.9	8.3	3,338.0	544.4	20.8
Tourism/ Recreation	2,800.1	15.5	0.7	265.8	13.4	6.4
Consumer goods	452.4	265.7	75.0	1,302.6	247.3	24.2
Service	10,826.0	19.2	0.2	146.0	5.1	4.5
Manufactured metal products	1,239.6	295.3	30.4	673.0	359.6	68.2
All sectors	24,942.5	1400.6	7.2	19,644.4	1,654.0	10.7

Note: * calculated as column 2 / column 1, multiplied by population in West Denmark/population in South Sweden. Source: Madsen and Jensen-Butler (1996).

The trade crossing Öresund is the subject in Madsen and Jensen-Butler (1996). Again, no primary statistics on trade exist, but via a number of assumptions synthetic data are constructed. It is concluded that the trade between greater Copenhagen and the rest of Denmark, is much larger than the trade between greater Copenhagen and the Southern Sweden. Normalising for the size of population, the export level to Southern Sweden from greater Copenhagen is 7 per cent compared to West Denmark, while the import level is 11 per cent. There are, however, major sectoral differences, as illustrated in table 3.

Data on tourism and shopping are rather limited. There are however numbers for Swedish tourists in Denmark, as published in Danmarks Turistråd (1998), cf. table 4. It is seen that one-day tourism (i.e. shopping) constitutes the major part of the money spent. To our knowledge, no data on the Danes behaviour in Sweden exist by now, but as noted in section 6, it is the plan to collect some data.

Besides the economic data as described above, there exist data on traffic flows. Data and forecasts for passenger and goods traffic crossing Öresund are presented in Øresundskonsortiet (1999), and summarised in Madsen (1999).

Table 4 Total money spent by Swedish visitors, 1996, according to their accommodation, in the Danish Part of the Öresund Region, as well as in entire Denmark, m. DKK

	Hotel business	Hotel, camping etc., private	One day tourists	Total
The Danish part of the Öresund Region	235	582	4,163	4,981
Entire Denmark	833	820	5,402	7,055

Source: Danmarks Turistråd (1998)/The TOEBBE model

3 A brief description of RAPS

RAPS is an overall model system. It has a modular character, comprehending regional as well as multiregional models, and models operating at varying time scales[3]. Version 1.0 of RAPS was released in 2000.

In Figure 2 the major parts of the model system are organised according to the time dimension (short, medium/long term), and regional level, (national/ regional/ municipal). Models at the municipality level are in fact mainly simple distributive post-models to the models at the regional level.

The regional model (short, medium term) is an economic/demographic model, primarily aimed at being a tool for analysis and forecasting for users at regional and municipal level.

- A region is primarily defined as a local labour and housing market (LHM). The operational definition may, however, be any group of spatially connected municipalities.
- The basic element of the regional model is information for municipalities; the model is specified and constructed from municipal data, and model results are brought back to the municipal level. For metropolitan regions, however, the aim is that analysis also will be performed at a lower, zonal level.
- The regional model consists of sub-models for population, production, labour market, housing market and commuting. Population is classified with respect to age, sex, native country, and education; production is grouped into some sixty industries, where labour demand is specified with respect to educational background.
- The regional model is run by exogenous demand directed towards regional production, with respect to gross investment, public consumption and net foreign exports. For these demand categories the model can, partly or wholly, be based on data from national forecasts (e.g., National Institute of Economic Research). Specific demand components may make use of alternative data, e.g. in case the user has prior knowledge of investment demand, and public consumption may be partly endogenous. The other main alternative for determining regional demand is using data from the multiregional model.

[3] It should be added that RAPS also will include an easy-accessible and tractable regional economic and demographic database. This will probably become the more frequently used part of RAPS.

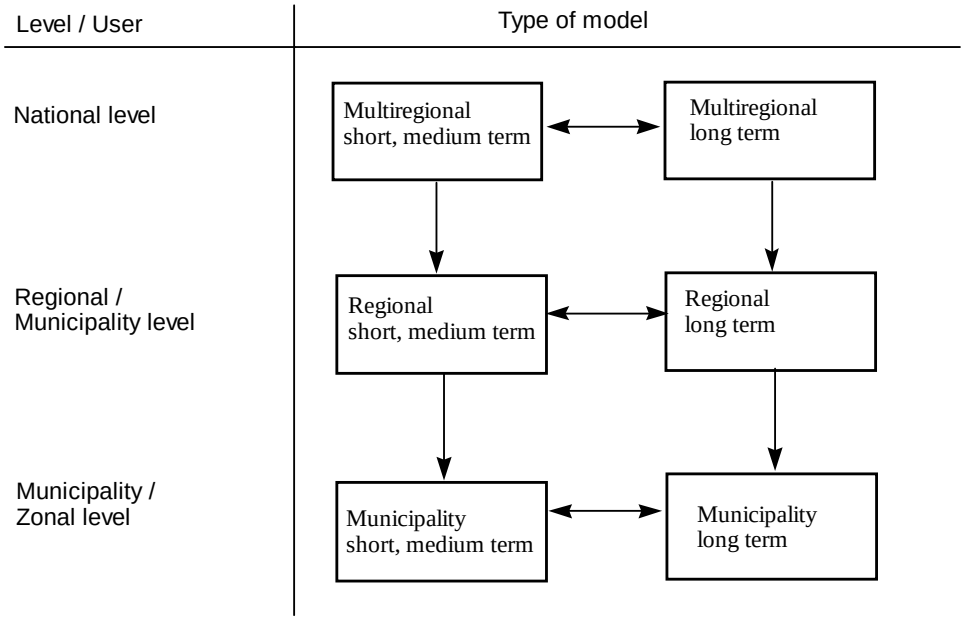

Fig. 2 The model system - an overview

The multiregional model (short, medium term) is an economic/demographic model, primarily aimed at being a tool for analysis and forecasting for users at the national level, and as a ”pre-model” to the regional model.

- Regions are defined as LHM, Sweden is subdivided into 81 regions.
- The production system (input-output model) is estimated on data at the county level and transformed to LHM.
- The multiregional model consists of sub-models for each region, each sub-model being a complete regional model as described above, where the multiregional model is balancing interegional trade and interregional migration.
- The multiregional model is run by exogenous demand directed towards regional production, with respect to gross investment, public consumption and net foreign exports. For all these demand categories the model makes use of data from national forecasts (e.g., National Institute of Economic Research), and specific ”project data” (e.g., national infrastructure investment), if any.

The multiregional model (long term) is a model for forecasting regional population and employment, primarily aiming at a model tool for users at the national level. The model may also be linked to the population sub-model in the regional model, e.g. when analysing regional long-term net migration.

- Regions are defined as LHM. This definition is fixed, but LHM may be revised.

– The basic element is information at LHM level, but some data used for estimation will be defined at a much more detailed level, including detailed transportation network data.

– The model consists mainly of two sub-models, for population and employment. In addition the model contains a set of regional ”attractors”, including data representing the quality of regional infrastructure. The model operates with total population and employment, i.e., there is no segmentation by education etc.

– The long-term multiregional model is a general equilibrium model where population and employment adjust to equilibrium with substantial lags[4]. The forecasts are constrained by the national long-term population forecasts, and long-term forecasts for employment participation rate.

– The long term (say, 20 years) implies that only aggregate forecast figures are relevant from model point of view. The result may, however, serve as a basis for calculations at a finer geographic level, and as a basis for segmentation of population and employment forecasts. Such demands may be raised in connection with national traffic planning.

In figures 3 and 4 two of five sub-models in the regional model are outlined. Relations within the respective submodel are shaded, and a dashed arrow means a lagged effect, e.g. the balancing of the labour market influences in- and outmigration the next year.

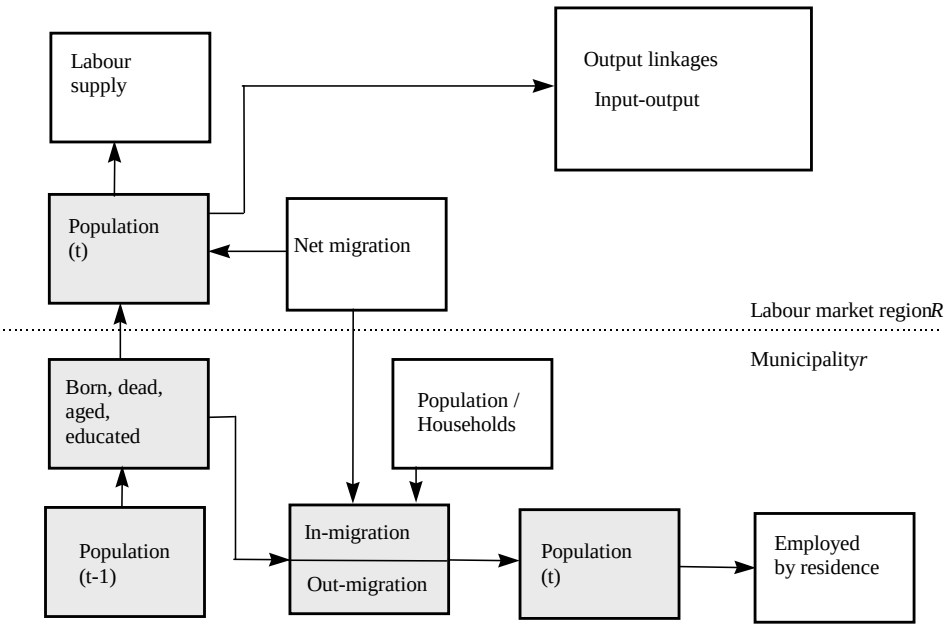

Fig. 3 Population sub-model in the regional model

[4] This model is drawing on the model formulation in Carlino and Mills (1987)

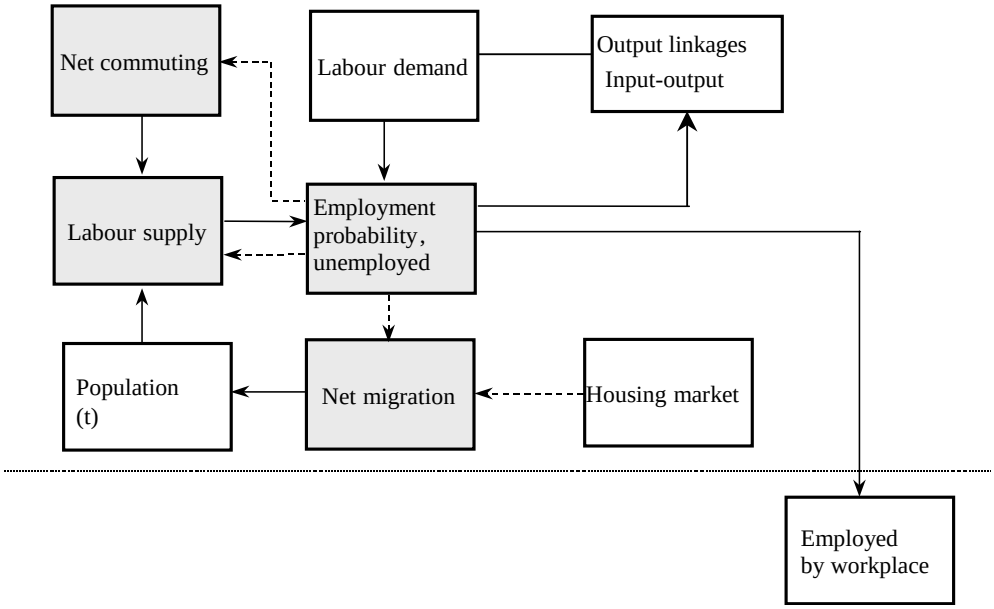

Fig. 4 Labour market sub-model in the regional model

4 A brief description of LINE

LINE is a model being built up at AKF, Institute of Local Government Studies - Denmark. It is a multi-regional macro economic model, covering the 275 municipalities in Denmark. The model is a natural successor to models at the county level which have been built up at AKF, i.e. AIDA and EMIL respectively. For a detailed presentation of LINE, see e.g. Madsen et al. (2001a).

The purpose of LINE is to enable different analyses of the local economies. The analyses cover a wide field as e.g. regional consequences of changes in national welfare politics and changed structures in the agriculture sector. For forecasts of these types, national forecasts have been supplied by ADAM (a national macroeconomic model) and AAGE (a national general equilibrium model), respectively.

A central part of the model building is the construction of data. The data are built up in a *Social Accounting Matrix* (SAM) approach. The data base which is built up is denoted SAM-K, and is further described in Madsen et al. (2001b). The primary data source is Statistics Denmark.

In the LINE model, the economic activity is classified according to different categorisation schemes inherent in the SAM approach. These are sectors, factors, institutions, demand components and commodities. Another classification of the economic activity is the geographical spot. All activities are classified to go on either at place of production, at place of residence or at place of demand. All 275 municipalities are possible values in these three categories. Right now, a project in AKF is to set up an

aggregate LINE model at county level (16 regions in Denmark), in order to increase the calculation speed, and to help on confidentiality problems.

These two different classification schemes are represented by the vertical respectively the horizontal axes in figure 5. The figure illustrates the *real circle* of LINE. This is a demand driven Keynesian model of economic activity. Starting in the upper left corner, a production is given in some specific sectors, in specific municipalities. The employees have a certain education, age and sex represented in the second row. Via commuting, income and number of employees are transformed to place of residence. The employees and the remaining population, all taken care of in a demographic sub-model to be built up, constitute certain households represented in the third row. Other institutions are e.g. the government. Via different transfers of income, the disposable income at place of residence comes up. The income is transferred to consumption of different demand components. Via shopping and tourism the consumption measured in demand components is given at place of demand. Intermediate consumption is added to obtain total demand, and via use matrices the total demand is transferred to commodities - still at place of demand. After subtracting import from abroad, total demand in commodities is transferred to place of production via a trade model. After adding exports abroad, left is only the transformation from commodities to sectors, captured via a make matrix.

The transformations described here capture the main elements of the real circle. The model is however to be supplemented with another part called the price/cost circle. It is illustrated in figure 6. The price/cost circle runs opposite the real circle. The aim is to introduce variable prices in the model, reflecting mark ups, transportation costs, taxes etc. By that trade, production, import, export etc. becomes dependent on the competitiveness of the products.

Starting again in the upper left corner, the sum of the factor costs and costs for intermediate input give rise to gross output in current prices. Via the make matrix, the current basic commodity prices come up. These prices are transformed to place of demand, giving rise to a price index showing the relative competitiveness of the municipalities. After adding of retailing and wholesaling profit, VAT and other indirect taxes, the commodity prices come up. These prices are transferred to place of residence, for shoppers as well as tourists, and to place of production prices for firms (for intermediate output). In this way private consumption, investments etc. are determined by market prices.

It is the intention that the two circles will iterate to equilibrium in a joint algorithm. In an analysis of the consequences of e.g. the fixed Öresund Link, the direct demand effects are captured by the real circle. It captures the changed demand for e.g. transport. As opposed to this, the cost circle captures the changed competitiveness for firms and the consumer advantages.

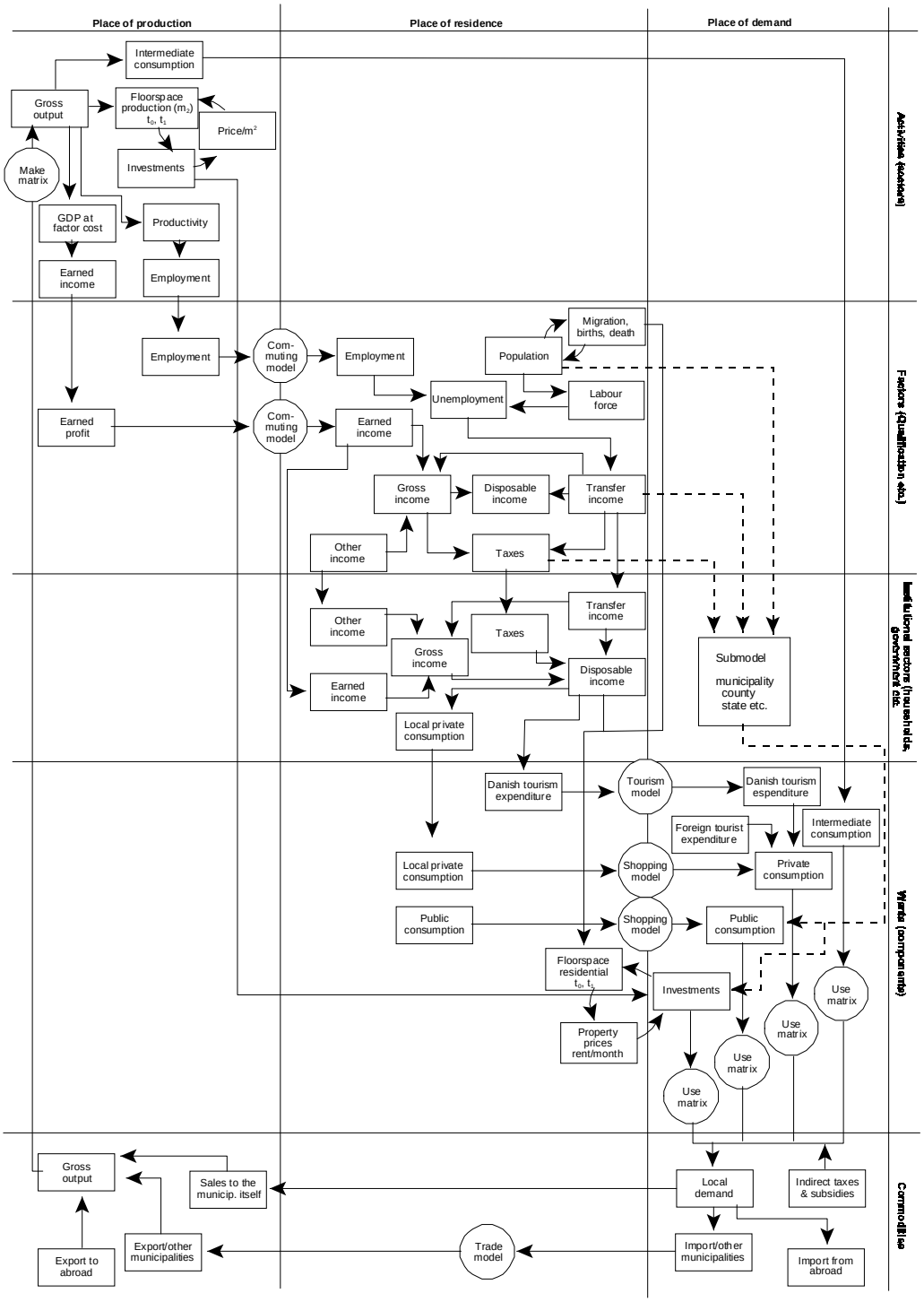

Fig 5 The real circle of LINE

Modelling of interaction is central in LINE. As described above several types of interaction are included in LINE, i.e. commuting, shopping, tourism and trade. Common for the types of interaction included is that the trips are connected to changes in the local economies, via transfer of values in some

way. The interaction goes on at the municipality level, and is, for all types, represented via complete interaction matrices. For example, the numbers of commuters between all municipality pairs are known as is trade (measured in value) between all municipality pairs. The actual number of trips is not modelled, but they are only a short step away; they could be found via trip frequencies.

Input-output matrices are standard tools in interregional models. The matrices capture interrelations between different *sectors*. In LINE make and use matrices are used instead, as noted in the description above. These matrices capture the interrelations between commodities and sectors instead. This is more appropriate for modelling demand for private consumption. Furthermore trade between firms in different municipalities is handled in commodities instead of in sectors.

The primary goal of the LINE model building is to keep track on the variables and the structures of the local economy. As a point of departure the models are built up with constant parameters. The long term goal is however to include coefficients reflecting behaviour, e.g. for commuting and/or migration.

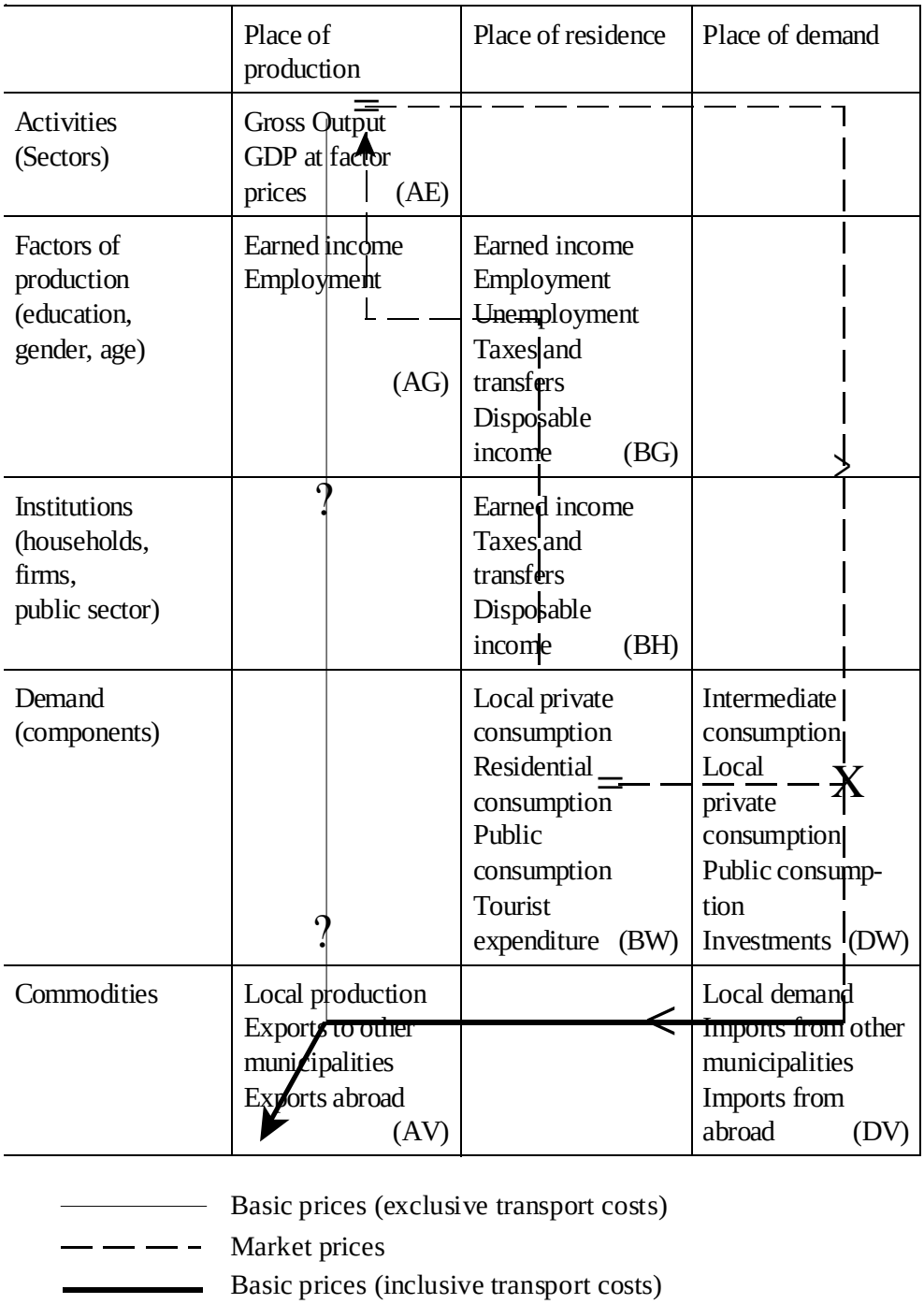

Fig 6 The price/cost circle of LINE

5 Linking LINE and RAPS – problems and prospects

Although LINE and RAPS have several features in common, a discussion about linking the two models should start by defining the differences, to see the basis for putting the two models together.

First, while RAPS is a regional economic *and* demographic model, including the housing market, LINE is only a regional economic model. Right now, LINE is however being enlarged with a demographic sub-model, but the housing market will not be included in the first run.

Second, RAPS includes a single region model as well as multiregional models. A region covers several municipalities, which are being used for data building. The calculated numbers of economic activity etc. are distributed back to the municipalities, mainly by a simple post-model. As opposed to this, LINE covers all municipalities of Denmark, i.e. 275. The municipality level is used for data building as well as in all calculations. It is, by that, a multiregional model for entire Denmark, but without the regions as middle level. The costs of this level of detail are of course low calculation speed and more data and programming work. The project described above on aggregating LINE to county level, will however ease calculations.

Third, while RAPS includes different (multiregional) models for short/ medium term and long term analysis, there is no such division for LINE. It could be argued, though, that the real circle with constant coefficients in LINE is appropriate for short term analyses, while the fully developed model including the cost circle is more appropriate for long term analyses.

Fourth, there is a difference as for the geographical division of activities in the models. A central point in the construction of LINE is the classification of all activities to the relevant geographical spot, as described above. This means that all activities are classified to go on either at place of production (or work), at place of residence, or at place of demand. In RAPS only two different places of activity are used, i.e. work and residence, implicitly assuming that place of demand equals place of residence.

The fifth difference is closely related. Shopping, commuting, tourism and trade are different kinds of activities which take place between the different geographical points defined in LINE (place of production, place of residence and place of demand). As described in section 4, these types of interaction are all represented via complete interaction matrices in LINE, e.g. the number of commuters between all municipality pairs. In RAPS, however, it is only commuting within a region that is represented with a complete interaction matrix. In the regional model trade, commuting and migration are not specified with respect to destination/origin, whereas in the multiregional model trade and migration is balanced by using a *pool approach*.

Sixth, economic activities are defined in different ways. In RAPS the economic activities are classified according to their sector. Furthermore, individuals are classified according to age, sex, native country and education. Almost the same classification is used in LINE, but in addition three other classification schemes are used, as described in section 4. These are institutions, demand components and commodities. The two latter categories are of course especially relevant due to the focus on place of demand. Since these categories are included, an alternative to input-output matrices, as used in RAPS,

comes up for LINE. This is make and use matrices, as described in section 4, which give a more relevant picture when handling private demand.

Seventh, RAPS is a fix price model - prices are only included with respect to (parts of) the housing market. In LINE prices will eventually be included, via the cost circle as described above.

To conclude, RAPS and LINE show substantial differences, and according to our view an effort to link the two models should, at least initially, be confined to a relatively simple 'interaction module'.

The interaction of main interest concerns trade of goods and services, commuting and migration. Taking the interaction in LINE as a point of departure implies inclusion of trade of goods, shopping, tourism and commuting. (Shopping and tourism can be closely interrelated, especially for Swedes going to Copenhagen to benefit from the variety of shopping possibilities as well as cultural sights). Also migration is relevant interaction. A suggestion of interaction data is given in table 4.

Table 4 Interaction data to be transferred between LINE and RAPS.

Interaction type	Unit(s)	Dimension(s)
Commuting	Number of persons, wage	Age, sex, education
Migration	Number of persons	Age, sex, education
Tourism	Money flows, number of persons	Components, accommodation type
Shopping	Money flows	Components
Trade	Money flows	Commodities

Not only interaction data should be transferred between the models. Also other variables are relevant, i.e. the variables influencing the different interaction types. In table 5, a suggestion of pull/push factors for the four different interaction types are given.

Table 5 Pull/push factors for the different interaction types to be transferred between the models.

Interaction type	Pull/push factors	Dimension
Commuting	Number of workplaces/ Workforce	Sectors/ Education groups
Migration	Number of workplaces/housing prices/amenities etc	Sectors/housing types/??
Tourism	Disposable income/ Tourist attractions	Family types/ Number of visitors
Shopping	Disposable income/ Shopping possibilities	Family types/ Turnover for shops or shopping areas
Trade	Demand for commodities/ Supply of commodities	Commodities/ Commodities

As noticed in section 2, variables describing the interaction across Öresund are lacking. Various initiatives are however taken in remedy of this shortage. Data on Danish export to Sweden before the bridge opening will be obtained from a survey financed by among others Transportrådet. A corresponding study for Swedish export to Denmark, is planned to be carried out by Statistics Sweden. Data for Swedes' shopping pattern in Denmark exist from a from surveys carried out for Danmarks

Turistråd, while another survey on Danes' shopping in Sweden will be carried out on behalf of Transportrådet. Data for tourist trips crossing Öresund are encompassed by the same surveys. Finally, data on commuting to work or education will be covered by the ØRSTAT project, which is a cooperation between Statistics Denmark and Statistics Sweden. For a further discussion of available data etc., see Madsen (1999). Due to different data sources there can be problems on transferability of data, and therefore, it can be necessary with some transformation schemes.

A first version of the 'Öresund model' could consist of three elements, the two models and a separate interaction module. Each model is solved separately, and (trade, commuting and migration) flows from/to the respective part of the Öresund region, are input into the interaction module. In this module the interaction flows are balanced and the result is input to a second round in the respective regional model. In this way, an iterative procedure is established, which hopefully will lead to convergence.

It may turn out that some of the current relationships in the respective model have to be modified to meet the requirements of such an approach, but this kind of questions have not yet been examined. It seems natural, though, to use some spatial interaction modelling for most interaction flows, and also to make use of already available parameters from the existing traffic models.

6 Concluding remarks

To do an ex ante analysis, the workable 'Öresund model' has to be run twice. First a base scenario is determined, with activities as expected *without* a fixed link. Next another scenario should be determined, *including* the fixed link. The two scenarios are compared to judge on the consequences of fixed link. One crucial point is of course how to include the fixed link, as already touched upon in the introduction.

To do an ex post analysis, it is crucial to be able to distinguish consequences of the fixed link from other changes in the economy. With a comprehensive structural model including the fixed link it is possible to decompose the changes in the economy into the different effects which are captured by the model. For a detailed discussion see Madsen (1999).

The immediate task, however, is to find a feasible way of linking the two models. The next step will then be to choose approaches for including the fixed link. Since the models are so different as described above, it is not just straightforward to choose a specific approach and carry out analyses. When the cost circle is built up in LINE it may be natural to take the cost approach. But since costs or prices are not directly included in RAPS, an alternative strategy must be chosen. As RAPS is demand driven a possibility would be to estimate the influence on the demand for products etc. from the region, outside the model.

Furthermore, as a part of the project, it is the plan to use different approaches, by that evaluating different ways of modelling regional economic impacts of infrastructure.

As a later step in the project, it is the hope to build up a more advanced model, for example by improving the existing models, as noted upon above.

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